

Design and Construction Process Management

David Brown, PE
Delcan Corp.
d.brown@delcan.com

Submitted Abstract

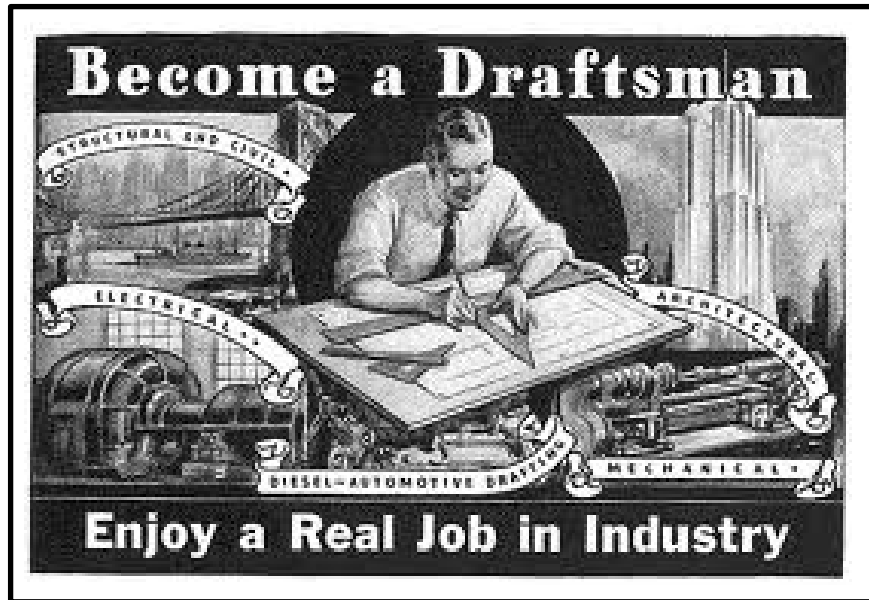
New approaches for improving design and construction processes have been used recently. Innovative methods for managing the requirements and quality of these processes will be discussed. A systematic data centric approach will be discussed as well as the processes of separating progress from performance. It will discuss the integration of these processes in the planning, risk analysis, design, submission, construction, inspection, quality control and documentation phases.

Three Take Away Points...

1. Analog to Digital
2. Progress VS Performance
3. Requirements Management

1. Analog to Digital ←
2. Progress VS Performance
3. Requirements Management

In Design...



ANALOG

DIGITAL



1. **Analog to Digital**
2. Progress VS Performance
3. Requirements Management

In Construction...



ANALOG

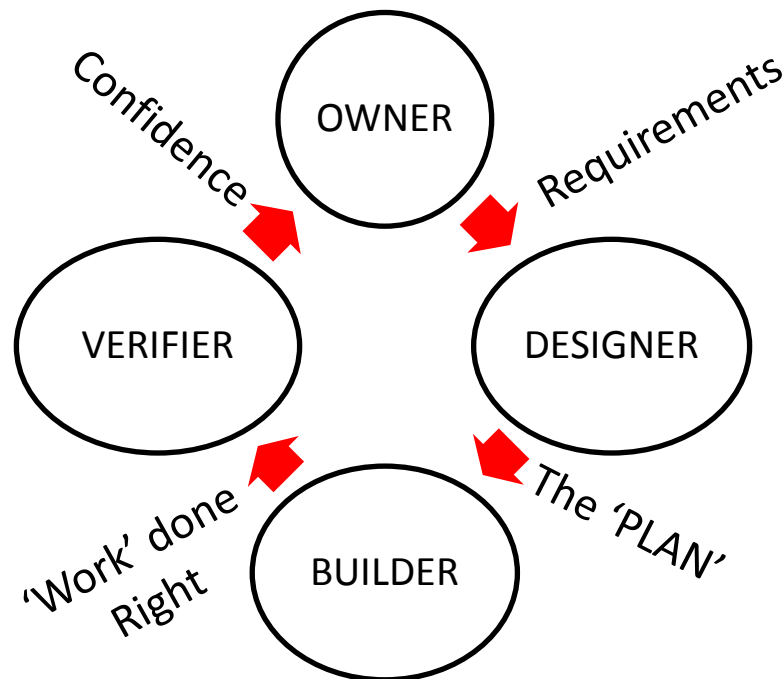
DIGITAL



1. Analog to Digital
2. Progress VS Performance
3. Requirements Management

WHY DO WE NEED TO 'CHANGE'?

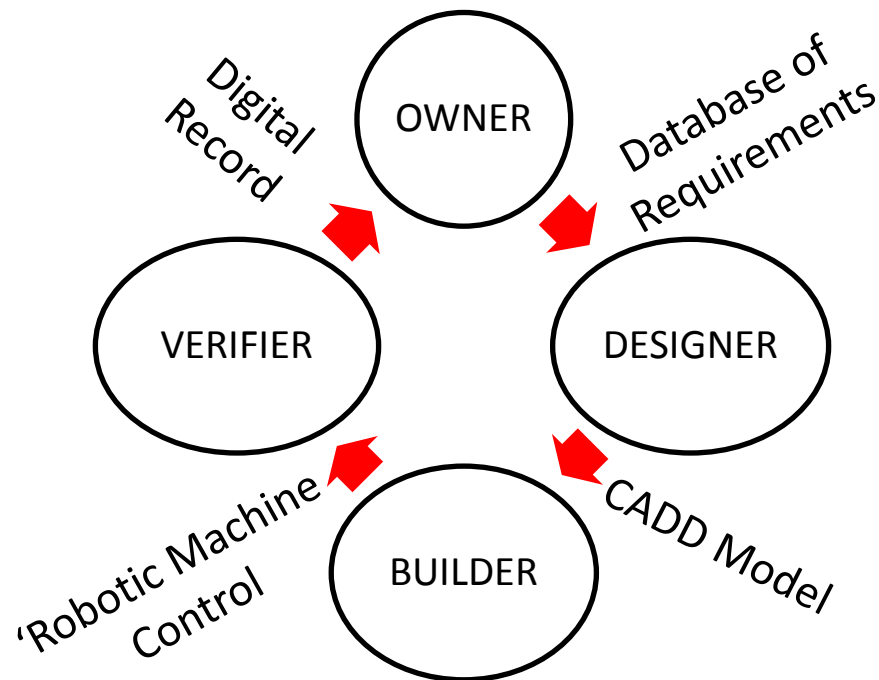
Understand **WHAT** needs to be Communicated?



1. Analog to Digital
2. Progress VS Performance
3. Requirements Management

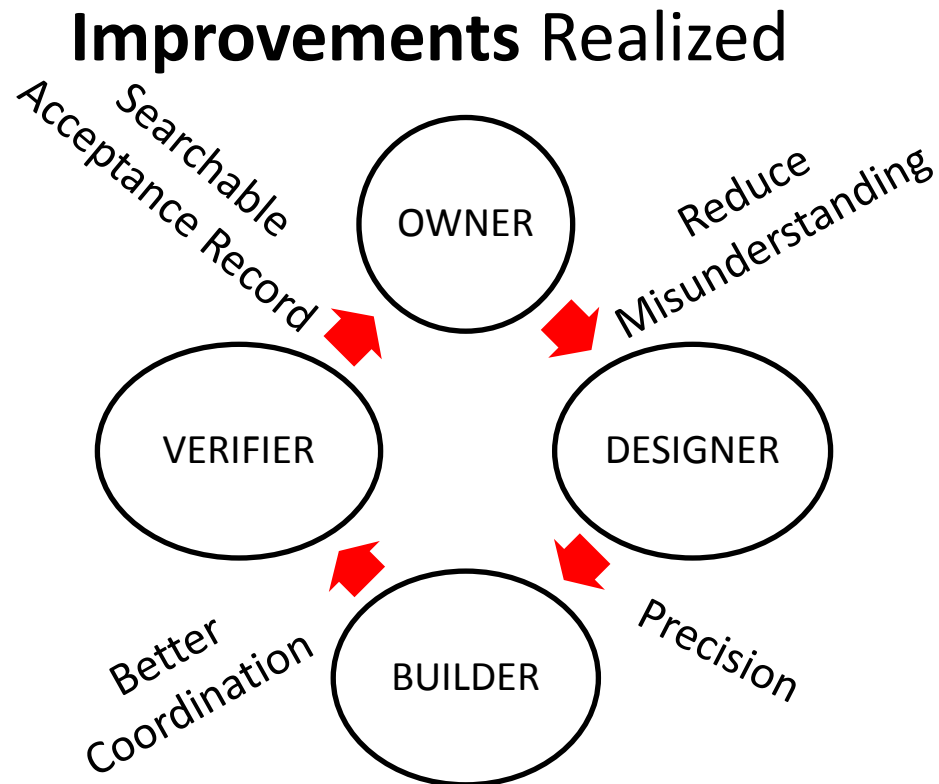
WHY DO WE NEED TO 'CHANGE'?

HOW will digital Improve Communications?



1. **Analog to Digital**
2. Progress VS Performance
3. Requirements Management

WHY DO WE NEED TO 'CHANGE'?



1. **Analog to Digital**
2. Progress VS Performance
3. Requirements Management

HOW DO WE DO THIS?

Communicate requirements in a database format as opposed to a 'novel' format

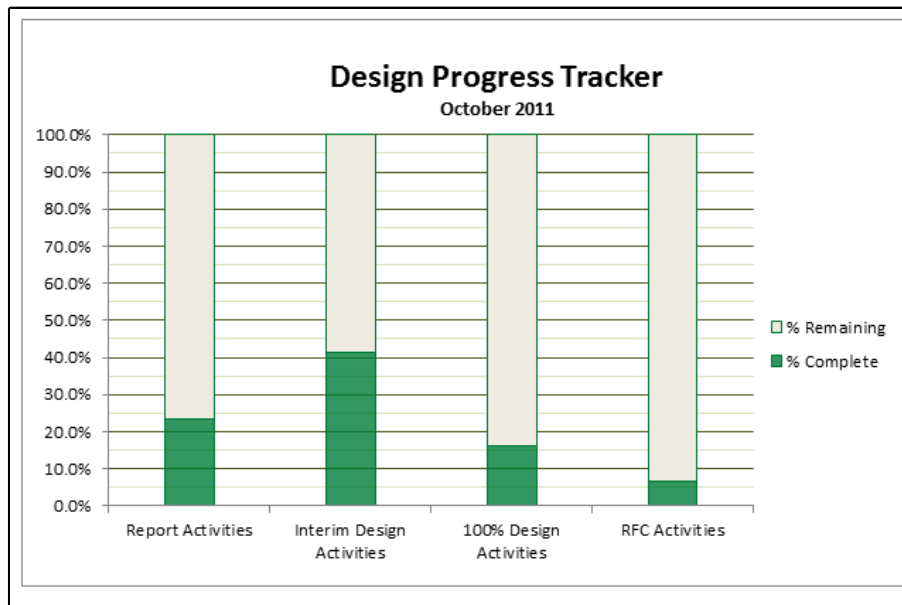
Deliver the design to the builder as a CADD model and let them figure out the best way to communicate it to their workers.

Leverage new technology to build with robotic precision where possible

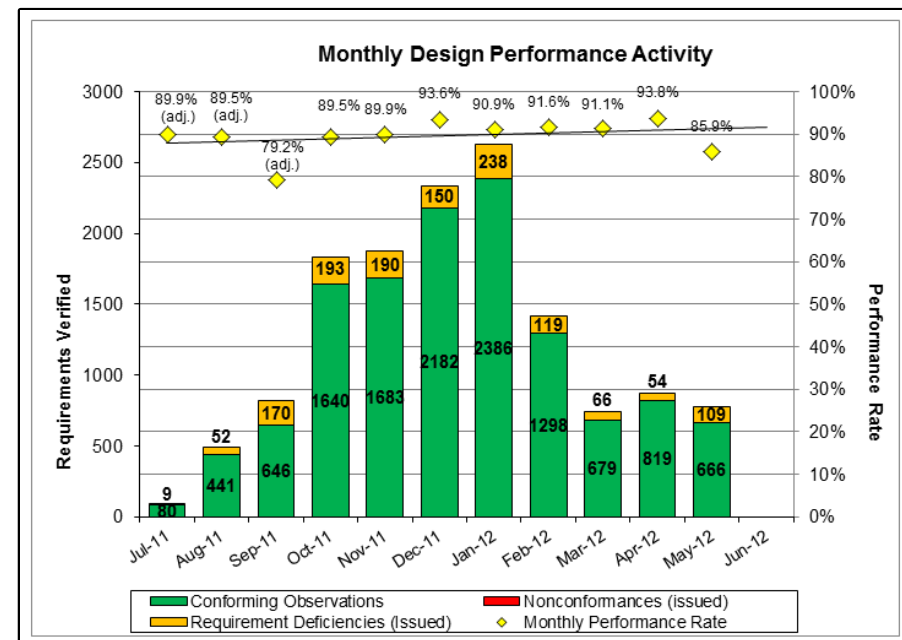
Embrace GPS enabled data collectors instead of hand written forms.

1. Analog to Digital
2. **Progress VS Performance** ←
3. Requirements Management

In Design...



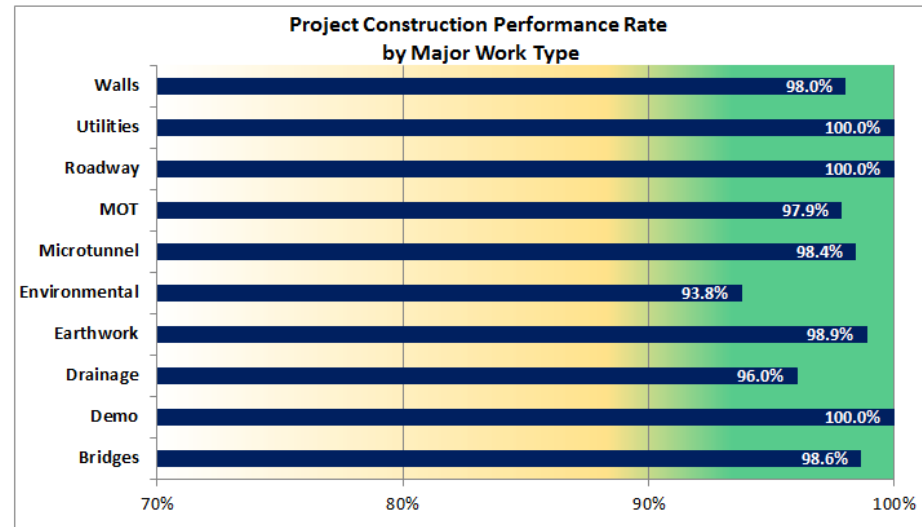
PROGRESS



1. Analog to Digital
2. Progress VS Performance
3. Requirements Management

In Construction...

PERFORMANCE



PROGRESS

Inspection Daily Report				Page 1 of 3				
Inspector / Technician: <u>Randy C. Graham</u> Date: <u>10/8/08</u>				Time on Site: <u>6:30</u> Time off Site: <u>5:30</u>				
No.	Seg. No.	Description of Work (Culvert, wall, fill, etc.) CWE	Supt. or Forman	Location: (Structure, stations, offsets, etc)	Inspections & Test Performed (List Forms, Sketches, Photos Attached)	Estimated Quantity (for test frequency)	Reference Plan Sheets, Specifications Nos., Details, etc.	A,F,N,C*
1	B3	BR-23 NB P.C. 7	Michael D.		Conformance / P.C.	225		A, C
2	B3	BR-14 Deck E.B. N. Piercap	Kyle Kern	Sta. 1122+50.21 to 10.0' P.C. 2	Conformance / Reg	133 CP 2	50400, 002, 010 - 013, 015, 027-032, 50400, 50605	A
3	B3	BR-14 Abut A. E.B. N. Piercap	Kyle Kern	Sta. 1122+01.89 to 12.21 P.C. 70	Conformance / Reg	—	50400, 002, 009, 011, 013, 50605	A, N
4	B3	Approach Slab Culvert 2, W-12 (W-12) (W-12)	Greg King	Sta. 1122+50.21 to 10.0' P.C. 2	Conformance / Reg	—	50400, 002, 009, 011, 013, 50605	A
<p>Observations (reference to No. above): (1) IC passed BR-23 NB P.C. 7 (33000) conc. mix BR-23 NB P.C. 7. 1 P.C. test performed. Fiber #42470 passed. (See P.C. report) assisted by S.E. Chasen, IC GC. Dave Rymis observed pour (See D. Rymis for details). (2) IC continued to set Architectural/Outside Blue and inside door forms BR-14 Deck E.B. N. Piercap. No new-conformant observed during placement (incomplete). (3) IC setting formwork for approach slab BR-14 E.B. Abut A. Remains deeper/piercap slab forms and set forms on top. Interfered w/setting. Applied curing agent (See #3A below). (4) IC prepared for W-12 Set Culvert 2. Supt./Schedule Tech onsite to perform Paving Capacity (See simulation descriptive record) approved by Tech/Schedule for further work completed. (4 total/mc-gress). (5) IC placed air fiber fabric in piercap/piercap area. Culvert 2. Placed stakes per plan to hold fabric. Follow-Up Items, Nonconformance, Corrective Actions (reference to No. above): (1) IC discontinued work curing and used liquid agent. Non-Conforming as per MD-55000 420.03, 03 Curing (b) 420.0207 Curing Methods (DCEP). (2) Supt./insure slab</p>								
Prepared By: <u>Randy C. Graham</u> Date: <u>10/8/08</u>		Approved By: <u>B.K. Dumas</u> Date: <u>10/10/08</u>		CQC Segment Manager				
<p>*Inspection Codes: A = Acceptable F = Needs Follow-up N = Nonconforming C = Work Completed</p>								

1. Analog to Digital
2. **Progress VS Performance**
3. Requirements Management

Why do we collect data on ...

PROGRESS

- ☐ Claim defense
- ☐ Let SR. management know something is happening
- ☐ Tell the 'story' of the project

PERFORMANCE

- ☐ Material test results
- ☐ Satisfy the FHWA
- ☐ Get enough tests to meet frequency guide

1. Analog to Digital
2. **Progress VS Performance**
3. Requirements Management

Issues with current practice ...

- ☐ Should be claim avoidance not defense
- ☐ Photos worth a 1000 words
- ☐ Boxes of paper don't always tell the full story
- ☐ Majority of issues result of workmanship, not materials
- ☐ Frequency of testing not adjusted for past performance

1. Analog to Digital
2. **Progress VS Performance**
3. Requirements Management

Benefits to be realized ...

- ☐ Use trained and qualified inspectors to measure performance of work
- ☐ Use time lapsed cameras to monitor progress of work
- ☐ Fewer inspectors more focused on what they are trained to do – inspect completed work
- ☐ Digital photography can provide a full, time-stamped story of how the work was completed – cheaply
- ☐ Tracking performance can highlight areas performing well and areas under performing

1. Analog to Digital
2. Progress VS Performance
3. **Requirements Management**



‘Requirements Management’... What is it???

“generally conforming to Contract requirements”

“**requirement**” = clearly communicated parameter

1. Analog to Digital
2. Progress VS Performance
3. **Requirements Management**

From a 'novel'...

702.10 Pumping Concrete

480 If the Contractor elects to convey concrete by means of pumping, the concrete shall be handled so as to minimize disturbance to the concrete which significantly alters the properties of the concrete being pumped, especially the loss or variability of the air content. The pumping equipment shall be mechanically sound, suitable in kind, and adequate in capacity for the proposed work. The concrete shall not be pumped through aluminum or aluminum alloy pipe. All pipes used for pumping concrete shall be kept clean and free from coatings of hardened concrete. Pump lines shall not rest directly on epoxy coated reinforcing bars. The pumping equipment shall be located such that operational vibrations will not damage freshly placed concrete.

490 When placing concrete directly from a truck mounted boom, the concrete pump lines shall have a flexible end section at least 10 ft (3 m) long. Methods of placement shall be such as to result in a steady and continuous discharge. If necessary, this may require the use of a restrictive device at or near the end of the discharge tube, the laying the flexible end section horizontally, or other means. For the initial placement of concrete pours which are predominantly vertical, the discharge end of the flexible end section shall be within 2 ft (0.6 m) of the bottom of the pour.

The Contractor shall submit a description of the pumping procedures which it intends to use, and shall notify the Engineer as to the pumping procedure at least 24 h in advance of concrete placement.

500

702.11 Cold Weather Concrete

When it is necessary to place concrete at or below an atmospheric temperature of 35°F (2°C), or whenever it is determined that the temperature may fall below 35°F

1. Analog to Digital
2. Progress VS Performance
3. **Requirements Management**

To a Database.

Manage Requirements

Checklist Back Close

WBS Requirements Checklists Search Submittals

Close

OHIO Columbus Crossroads Project

- Scope
 - Change Order 1
 - Appendix AE-02
 - 1 General
 - 2 Quality Management
 - 3 Document Management
 - 4 Public Information and Communication
 - 5 Environmental Commitments
 - 6 Utilities
 - 7 Right-of-Way
 - 8 Geotechnical
 - 9 Pavements
 - 10 Roadway Design
 - 11 Drainage
 - 11.1 Governing Regulations for ODOT Facilities
 - 11.2 Governing Regulations for Local Facilities
 - 11.3 Notes and Specifications
 - 11.4 Requirements**
 - 12 Structures
 - 13 Noise Walls
 - 14 Aesthetics and Enhancements
 - 15 Traffic Control
 - 16 Maintenance of Traffic
 - TC 03 - Temporary Signal
 - Environmental Documents
 - AASHTO
 - City Of Columbus standards
 - Federal Standards
 - ODOT Manuals
 - Supplemental Specifications
 - ODOT Specifications
 - Quality Management Plan
 - Generic Plan Requirements
- Functional Requirements : Ohio IQF Requirement Verification Database

Add New Requirements

Description	Additional Reference	Severity	Probability	Detectability

Existing Requirements: 60 Records

Select All Deselect All Hide Export Grid

Select	Hide	ID	Description
<input type="checkbox"/>	<input type="checkbox"/>	30919	Bridge deck drainage design - Conform to ODOT's L&D Manual Volume 2 Drainage Design, section 1103, section 1113 - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30920	Spring Street Bridge and Long Street Bridge drainage design - Refer to Appendix AE-02, the Spring and Long Street Bridge Landscape Enhancement Plan, for the proposed drainage design, plan sheets, details, and specifications - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30921	Spring Street Bridge and Long Street Bridge underdrain design - provide a dual system of underdrains and a continuous drainage mat - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30922	Spring Street Bridge and Long Street Bridge underdrain design - place the underdrains under all lawn and planting areas with a 6" layer of porous backfill on top of the continuous drainage mat - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30923	Spring Street Bridge and Long Street Bridge underdrain design - continue the continuous drainage mat beyond the planting areas under paved areas as detailed in Appendix AE-02 - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30924	Spring Street Bridge and Long Street Bridge underdrain design - provide a continuous drainage mat conforming to specifications provided in the landscape plan notes in Appendix AE-02 - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30925	Spring Street Bridge and Long Street Bridge Waterproofing - provide waterproofing membrane between the drainage mat and the bridge deck - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30926	Spring Street Bridge and Long Street Bridge Waterproofing - wrap the waterproofing membrane vertically over the joint at joint locations (i.e. planter walls, foundations, etc.) and continue to the top of the element per the details in Appendix AE-02 - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30927	Spring Street Bridge and Long Street Bridge Waterproofing - provide water stops at the parapet wall and under the stairs - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30928	Spring Street Bridge and Long Street Bridge underdrain design - follow the profile grade of the bridge with underdrains and drainage mat - DESIGN
<input type="checkbox"/>	<input type="checkbox"/>	30929	Spring Street Bridge and Long Street Bridge underdrain design - no provision for transverse slope in the system - DESIGN

ID=85; Parent= 81 \OHIO Columbus Crossroads Project\Scope\11 Drainage\11.4 Requirements

16

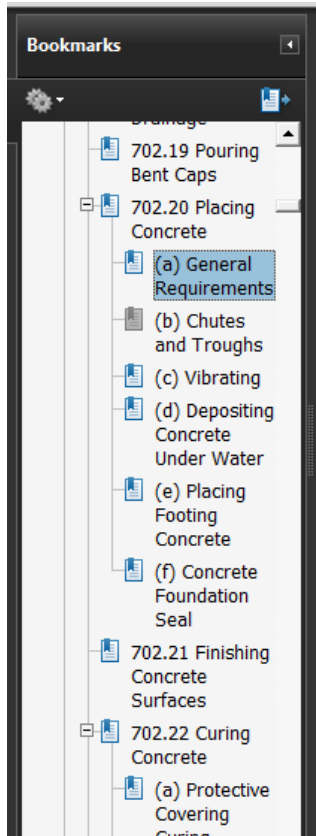
start Adobe Acrob... Sent - Micros... Microsoft Excel Ohio IQF - ... Main Menu Manage Req... Search Desktop 7:22 AM

1. Analog to Digital
2. Progress VS Performance
3. **Requirements Management**

Traditional Approach...

Section 700 – Structures – 233 pages

How many requirements????



(b) Chutes and Troughs

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. Open troughs and chutes shall extend as nearly as possible to the point of deposit. Equipment made of or coated with aluminum alloys shall not be used to transport concrete. Pumping of concrete shall be in accordance with 702.10. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided. Placement of supplementary bins or hoppers may be ordered above the point where concrete is being deposited. The concrete shall be allowed to accumulate in these containers in considerable quantity and shall be discharged immediately through pipes extending from the bottoms of these bins or hoppers. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete. The water used for flushing shall be discharged clear of the concrete already in place.

Concrete shall not be dropped in the forms a distance of more than 5 ft (1.5 m) except when confined by closed chutes or pipes. Each part of the form shall be filled

1. Analog to Digital
2. Progress VS Performance
3. **Requirements Management**

Requirements Management Approach...

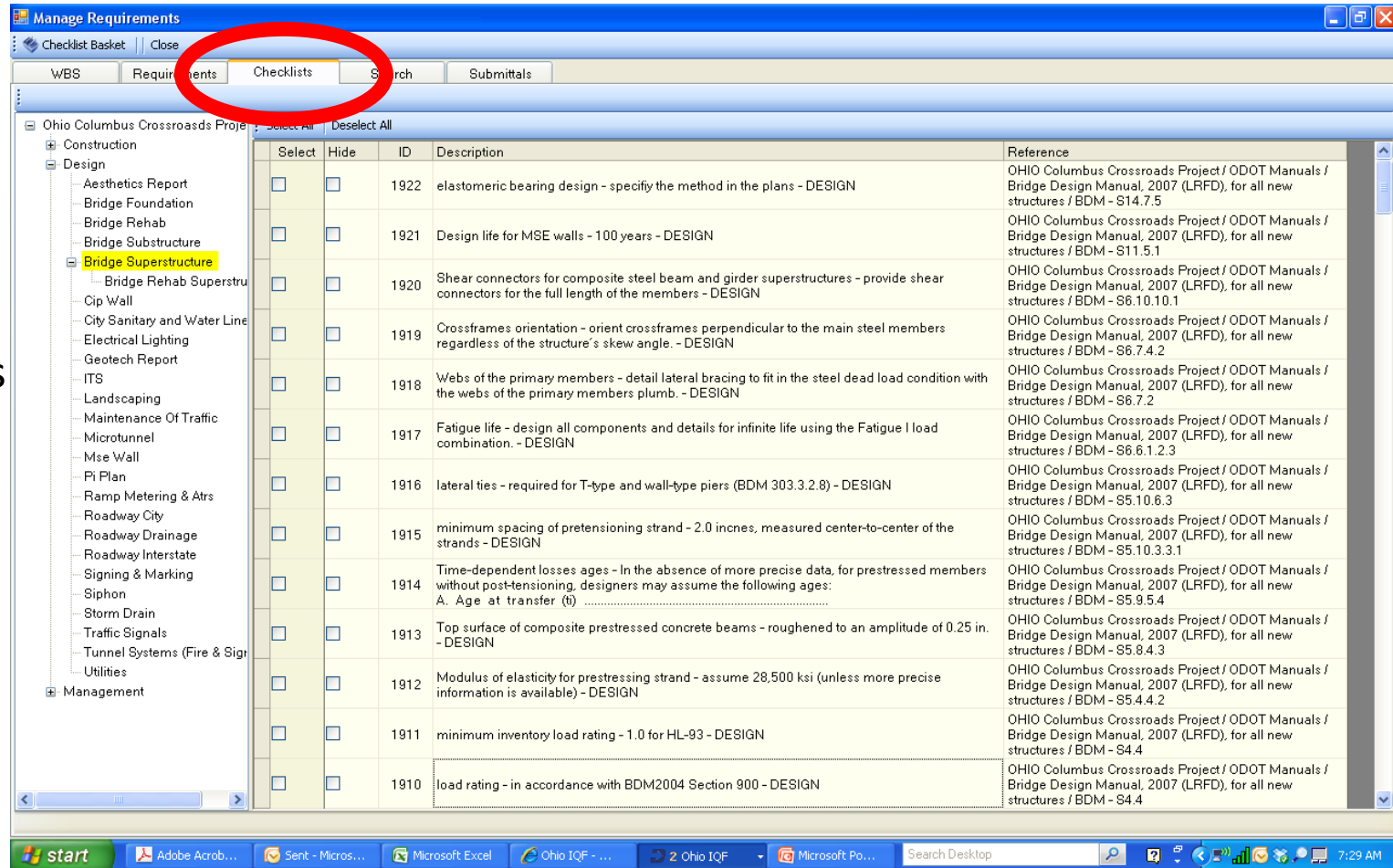
Identify
individual
requirements
into a table
format

						phase
					Technical Provisions	
1					3 DESIGN QUALITY ASSURANCE, QUALITY CONTROL, AND OVERSIGHT	
2					3.1 Designer Responsibilities	
3					Developer shall verify pertinent dimensions in the field prior to the review of Design Documents, Plans, and Construction Documents.	design
					Design Documents, Plans, and Construction Documents shall be subject to IFA's Design Review before beginning construction work covered by the Plans, and shall not be thereafter amended or altered without the prior approval of Developer's Designer and subsequent Design Review by IFA.	design
4					3.2 Developer's Design Organization and Obligations	
5					3.2.1 Designer	
6					Developer shall appoint a suitably qualified and experienced Designer,	management
7					3.2.2 Location of Developer's Designer	
8					the Key Personnel shall be assigned primarily to the Project Office	management
9					3.2.4 Lead Engineer	
10					Developer shall designate and assign a Lead Engineer to manage all Work performed by Developer's Designer (Lead Engineer).	management
11					The Lead Engineer shall be located in the East End Crossing vicinity as required for the Design Work,	management

1. Analog to Digital
2. Progress VS Performance
3. **Requirements Management**

Build a database of requirements...

Dynamic
checklists of
discipline
specific
requirements



1. Analog to Digital
2. Progress VS Performance
3. **Requirements Management**

Assign attributes to requirements...

- Tactical level RISK
- PHASE of project delivery
- OWNER – applicable jurisdiction
- Estimated COST
- VERIFICATION responsibility
- Others...

1. Analog to Digital
2. Progress VS Performance
3. **Requirements Management**

Requirements Management Approach...

Benefits to be realized ...

- ☐ Apply relevant attributes to requirements
- ☐ Measure performance over time
- ☐ Consistency in requirement selection and verification
- ☐ Reduce risk of misunderstanding expectations

Summarize Take Away Points...

1. Analog to Digital
2. Progress VS Performance
3. Requirements Management

Contact Information...

David Brown, PE

Delcan Corporation

26 West Dry Creek Circle, Suite 616

Littleton CO, 80126

d.brown@delcan.com

303-419-4696